A study on industrial structure optimization by establishment of cross-border e-commerce pilot zones in the yangtze river delta: perspectives on the differences among prefecture-level cities

Qian Chen[a], Li Qiuyu*

[a]qianchen@zisu.edu.cn, *24517534@qq.com

School of International Business, Zhejiang International Studies University, Hangzhou, 310023, China

Abstract. This paper investigates the impact of cross-border e-commerce pilot zones on the optimization of the industrial structure in the Yangtze River Delta region, a pivotal area for China's economic development. It commences with a review of relevant literature and theoretical underpinnings concerning cross-border e-commerce and its influence on industrial structure. The study then provides a detailed account of the pilot zones' development and the region's current industrial structure, exploring the mechanisms that contribute to structural optimization. Utilizing a multi-period double difference (DID) method on panel data from 41 prefecture-level cities spanning from 2011 to 2020, the research meticulously assesses the impact of the pilot zones. The findings are validated through robustness tests and heterogeneity analyses, yielding significant insights. The study discerns that the establishment of pilot zones significantly bolsters the optimization of the industrial structure in Yangtze River Delta. The impact varies based on city size, administrative level, and the order of establishment. Three principal intermediary mechanisms are identified as catalysts for this optimization: the innovation-driven effect, which stimulates technological progress and innovative business models; the industrial agglomeration effect, which strengthens industry concentration and competitiveness; and the resource allocation effect, which enhances the efficiency of resource distribution across sectors. The article concludes with strategic recommendations to inform policy and institutional innovations, aiming to further refine the regional industrial structure within Yangtze River Delta.

Keywords: cross-border e-commerce pilot zone, industrial structure upgrading, difference in difference

1. Introduction and literature review

Since China began to implement the reform and opening-up policy in 1978, foreign trade has experienced rapid development for thirty years, while in the past ten years, the growth rate of foreign trade has dropped significantly and entered a stable development trend. In order to stimulate innovation and balanced regional development, and promote industry upgrading, Hangzhou became the first Cross-border E-commerce Comprehensive Pilot Zone established in China in 2015. As of May 2023, the State Council has established 165 Pilot Zones covering 31 provinces, autonomous regions and municipalities. Driven by the local pilot policy, e-business has become the fastest growing, the largest potential form of foreign trade in China. However,

ECIT 2024, March 15-17, Changsha, People's Republic of China

DOI 10.4108/eai.15-3-2024.2346190

from the perspective of resource distribution between urban and rural areas, it is easier for cities with higher levels of competence to take advantage of policy dividends, thereby attracting manpower, capital and other resource elements. In a number of symposiums, owners of cross-border e-commerce enterprises located in the outskirts of cities or in the countryside have indicated that it is becoming increasingly difficult to recruit suitable employees, which is a more obvious contrast with the same type of enterprises in the cities. Therefore, this paper hopes to reduce the granularity of the study, descending from the previous provincial level to the city level, to study the heterogeneity effect brought about by the policies of the pilot zone.

Previous studies mainly focus on the following three vectors. Firstly, pilot zones influence the optimisation of industrial structure through innovation-driven effects. According to the theory of industrial structure, institutional innovation and scientific and technological innovation are the core driving forces to promote the optimisation and upgrading of industrial structure and economic growth[1]. The innovative policies of the special block have facilitated the transformation of regional industries into capital-intensive and technology-intensive industries[2], i.e., they have facilitated the dynamic transformation of the regional industrial structure from low-level to high-level. Secondly, the pilot zone influences the optimisation of industrial structure through the industrial aggregation effect[3]. There are obvious regional differences and complementary advantages among the various pilot zones in China. In order to promote industrial upgrading more effectively, it is necessary to strengthen the synergy and cooperation between different pilot zones. Third, cross-border e-commerce pilot zones affect the optimisation of industrial structure through resource allocation effects. There are many problems in the market, such as monopoly, public goods, information asymmetry and externalities, which can lead to market failure[4]. In order to solve these problems, the comprehensive pilot zones policy adopts "tangible hand" to rationally allocate resources[5]. By combing the previous literature and combining with the current development situation, it can be found that the pilot zones have a greater possibility to promote the optimisation of industrial structure through the innovation-driven effect, industrial aggregation effect and resource allocation effect. Figure 1 shows the path of the mechanism of the establishment of pilot zones on the optimisation of industrial structure.

2. Methodology

2.1 Data sources

The time span of this paper's study is from 2011 to 2020, and the study object is the 41 prefecture-level cities in Yangtze River Delta. By the end of 2020, 24 national-level comprehensive cross-border e-commerce pilot zones have been established in the Yangtze River Delta, and a total of 18 cities set up pilot zones after 2021, which will be used as a control group in this paper due to their short implementation time. Notably, Yiwu pilot zone was set up in 2018, while Jinhua City's was set up in 2022. However, Yiwu's cross-border e-commerce transaction volume accounts for a significant portion of Jinhua City's, and it ranked in the top tier in the national assessments in 2021 and 2022, therefore, this paper replaces the Yiwu comprehensive pilot zone (county-level city) with the Jinhua comprehensive pilot zone (prefecture-level city) data instead, thus the number of cities in the control group became 17. The city data used in this paper mainly come from the Statistical Yearbook of Chinese Cities

from 2011 to 2020, as well as the statistical yearbooks. The list of pilot zones published by the State Council is also referenced (see Table 1). In this paper, some of the missing values are supplemented by interpolation method, and data processing and analysis primarily rely on Excel and Stata17.

Table 1. List of Comprehensive Pilot Area for Cross-border E-commerce in the Yangtze River Delta Region

Province or Municipality	Experimental Group	Time of Approval	Control group	Time of Approval
Zhejiang	Hangzhou	2015	Jinhua, Zhoushan	2022
	Ningbo	2016		
	Yiwu	2018		
	Wenzhou, Shaoxing	2019		
	Huzhou, Jiaxing, Quzhou, Taizhou, Lishui	2020		
Jiangsu	Suzhou	2016	Yangzhou, Zhenjiang, Taizhou	2022
	Nanjing, Wuxi	2018		
	Xuzhou, Nantong	2019		
	Huai'an, Changzhou, Suqian, Lianyungang,Yancheng	2020		
Anhui	Hefei	2016	Bengbu, Huainan, Huaibei, Fuyang, Lu' an, Bozhou, Ma 'Anshan, Suzhou, Xuancheng, Tongling, Huangshan, Chuzhou, Chizhou	2022
	Wuhu	2019		
	Anqing	2020		
Shanghai	Shanghai	2016	-	-

2.2 Variable description

2.2.1 Dependent variable

The dependent variable is industrial structure optimization, and it will be analyzed in terms of industrial structure advanced and industrial structure rationalization, which is mainly manifested in the fact that the proportion of the tertiary industry in the three industries is increasing. This paper adopts industrial structure advanced (*ser*), which is the most commonly used method by the current researchers[6,7,8], and it is capable of reflecting the relative changes of the output value of the secondary and tertiary industries. The formula can be written as follows:

$$\mathrm{ser} = Y3 / Y2 \tag{1}$$

Where *ser* indicates the level of industrial structure optimization, and Y_3 and Y_2 indicate the output value of tertiary industry and the output value of secondary industry, respectively. The lager value of *ser* indicates higher level of industrial structure advanced, and vice versa. Academics mostly use Hamming closeness, industrial structure deviation for industrial structure rationalization (*rat*). In order to reflect the evolution pattern of the output value structure and employment structure, as well as the economic status of three industries, this paper chooses the

industrial structure deviation to measure the industrial structure rationalization[9], which is given as follows. Where Q represents the output value, L is the employment, and i is the industry.

$$\text{rat} = \sum_{i=1}^{3} \left| \frac{Qi / Li}{Q / L} - 1 \right| = \sum_{i=1}^{3} \left| \frac{Qi / Q}{Li / L} - 1 \right| \tag{2}$$

2.2.2 Independent variable

The independent variable of this paper is the pilot zone policy shocks *id (treat*post)*. In this paper, the 24 cities set up pilot zones by 2020 are taken as the experimental group, while the remaining 17 cities are taken as the control group. Two dummy variables are set, the first dummy variable is *treat*, *treat=1* for the experimental group and the dummy variable *treat=0* for the control group. The second dummy variable is *post*, with 2015-2020 being the interval of the year when the cities in the experimental group started to implement the policy of pilot zones, which is denoted as *post=1,* and the period of 2011-2014, which is denoted as *post=0*. The the double difference term is denoted as *did,* which presents the influence of pilot zones on industrial structure optimization.

2.2.3 Control variable

The level of economic development, a very important variable affecting the optimization of industrial structure, is expressed in this paper using logarithmic regional GDP. The level of opening up, the total amount of regional import and export trade, is taken as logarithmic. The level of social consumption, measured by the proportion of total retail sales of consumer goods to GDP. Human capital level, expressed as the number of students enrolled in the region's colleges and universities divided by the region's total population, logarithmized. Population density, measured by logarithmizing the area of administrative regions. Social financing scale, measured by the year-end deposit and loan balances of financial institutions as a share of GDP. Infrastructure development, measured by road area per capita in cities. Informatization level, expressed by logarithmization of the number of international Internet users.

2.2.4 Intermediary variable

This paper chooses the level of technological innovation as the mediating variable, which is measured using the logarithmized number of patents granted. The level of government expenditure is measured by the proportion of government fiscal expenditure to GDP to characterize the resource allocation effect and bring it into the mediating effect model. The industrial agglomeration effect is mainly the agglomeration of productive service industry, which is measured by using the location entropy of productive service industry, and the specific calculation formula is as follows:

$$\text{agg}_{it} = \left[\frac{e_{ij}(t)}{\sum_i e_{ij}(t)} \right] / \left[\frac{\sum_i ei_j(t)}{\sum_j \sum_i ei_j(t)} \right] \tag{3}$$

where agg_{it} denotes the value of locational entropy of city i in period t, and $e_{ij}(t)$ denotes the number of people employed in industry j in city i.

2.2.5 Descriptive statistics of variables

The collected data of 41 cities in three provinces and one city in this region from 2011 to 2020 are organized and processed. Logarithmization is done for *gdp, foreign, and area*, and the descriptive statistics function of Stata is used to analyze the data, and the statistical results are resented in Table 2.

Table 2. Descriptive statistics of variables

Variable	Observed Value	Average Value	Standard Deviation	Minimum Value	Maximum Value
ser	410	0.987	0.341	0.310	2.750
rat	410	5.061	8.937	0.020	67.530
did	410	0.112	0.316	0	1
lngdp	410	7.877	0.950	5.920	10.56
lnforeign	410	6.212	1.798	2.566	10.46
retail	410	0.410	0.192	0.138	2.479
lnedu	410	1.828	1.014	-0.558	4.520
lninternet	410	13.87	0.907	11.44	16.02
lnarea	410	8.931	0.575	7.015	9.820
deposit	410	1.608	0.991	0.730	13.55
infra	410	22.69	7.212	4.040	46.40
lnpatent	410	8.876	1.322	5.680	11.85
gov	410	1.839	0.771	0.896	4.072
agg	410	0.533	0.183	0.0750	2.303

2.3 Model specification and estimation

In recent years, many scholars have used empirical methods to analyse the policy effects of pilot zones. There are many assessment methods used for policy effects[8], and common experiments include difference in difference[10,11] (DID), synthetic control method[10] (SCM), regression synthesis method (HCM), regression discontinuity (RD), etc. Heckman firstly introduced the DID method into the evaluation of policy effects, which opened up the application of the DID method to the study of this field. And there are also many scholars in China who use the DID method for the evaluation of policy effects, such as the study of "civilised cities", "national high-tech zones", and "the construction of free trade zones" and other impact situations brought about by the implementation of policies such as " civilised city", "national high-tech zone", "free trade zone construction" and so on.

Considering that the pilot zones in each city were set up in different periods, therefore, adopts a multi-period double-difference method to test the impact of the construction of pilot zones on optimisation of industrial structure. This study also includes indicators of human capital investment, foreign direct investment inflows, and economic openness as the control variables. The specific model is written as follows：

$$\text{struc}_{i,t} = \beta_0 + \beta_1 * did_{i,t} + \beta_2 * X_{it} + \mu_i + \eta_t + \varepsilon_{i,t} \tag{4}$$

where *i* denotes the country and *t* represents the year. X_{it} is a control variable. did_{it} is a double-difference term for the cities that have implemented the pilot zone policy in that year as well as in the following years. εit is a random disturbance term, μ_i is an individual fixed effects, η_t is

time fixed effects, β_0 is a constant term, and β_2 is a vector of estimated coefficients for the control variable X.

3. Empirical results

3.1 Regression results

The present study investigates the single and double threshold effects in model[11]. Controlling for individual and time effects as well as control variables, the regression coefficient for advanced industrial structure is 0.071, which is significantly positive at the 1 per cent level; for rationalisation of industrial structure (see Table 3). This shows that pilot zones give a significant contribution to industrial structure improvement, both in industrial sophistication and rationalisation. These results provide further support for robustness analysis.

Table 3. Preliminary regression results

Variable	*ser*	*ser*	*rat*	*rat*
did	0.048*	0.071***	-1.190	-1.743**
	(0.026)	(0.026)	(0.828)	(0.880)
lngdp		0.157**		-4.389*
		(0.075)		(2.536)
lnforeign		0.031		1.503
		(0.035)		(1.174)
retail		0.605***		-5.571*
		(0.125)		(3.235)
lnarea		0.116**		-0.040
		(0.058)		(1.957)
deposit		-0.108***		-0.050
		(0.029)		(0.964)
infra		0.003		-0.116*
		(0.003)		(0.069)
lninternet		0.094***		-2.056**
		(0.030)		(1.027)
lnedu		0.151***		-1.528
		(0.046)		(1.570)
_cons	0.747***	-0.257	2.994***	61.542**
	(0.018)	(0.782)	(0.587)	(26.424)
N	410	410	410	410
r2	0.726	0.760	0.258	0.794
city	yes	yes	yes	yes
time	yes	yes	yes	yes

(Standard errors in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01)

3.2 Parallel trend test

The prerequisite for adopting the difference in difference method is to pass the parallel trend test, the core idea of which is to test whether there is a difference in the trend of change between treatment and control groups. In order to avoid the problem of covariance, the previous period of policy implementation is chosen as the base period, so as to facilitate the comparison of other

periods with the base period to judge whether there is a difference between treatment group and control group.

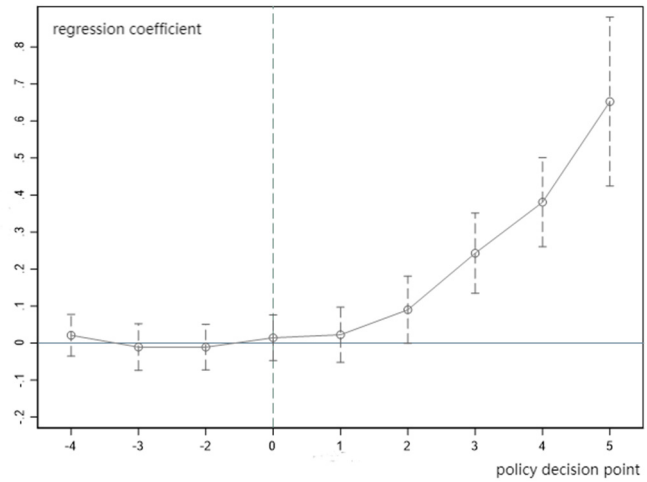

Figure 1. Parallel trend test with *SER* as explanatory variable

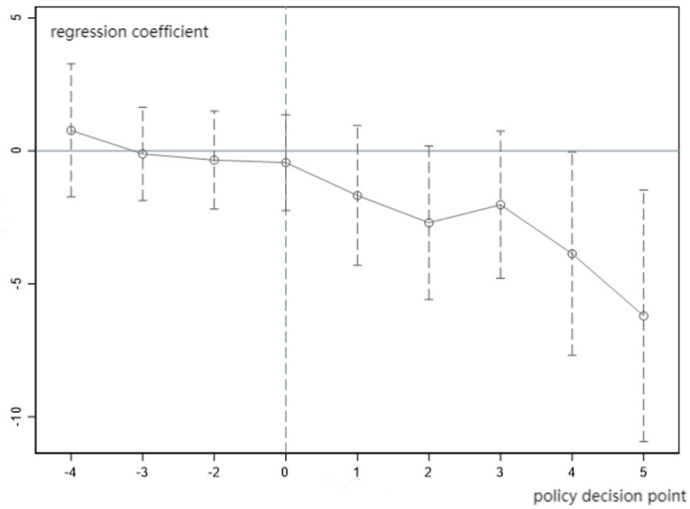

Figure 2. Parallel trend test with *RAT* as the explanatory variable

As can be seen in Figure 1 and 2 , the regression coefficients of the pilot zones on the advanced industrial structure and the rationalisation of the industrial structure are not significant in the first four years of the implementation of the policy, which means that before the establishment of the pilot zones, there is no significant difference between the establishment of pilot zones and the absence of pilot zones, which suggests that it passes the parallel trend test, so that double-difference can be used to test the effect of the pilot zones on the optimisation of the industrial structure.

4. Robustness test

In order to test whether the pilot zone policy is affected by other policies and randomness factors, this paper conducts a placebo test by fictionalizing the treatment groups and using random sampling, i.e., selecting the policy implementation targets by random sampling, obtaining a new, fictional 24-treatment group and a new 17-control group, and conducting double-difference scores using the new treatment and control groups. If the coefficient of the spurious treat*post is not significant, it indicates that there is no policy effect of the establishment of the IFZ on the randomly selected treatment group. Repeat the above process 500 times to obtain 500 separate estimated coefficients and plot the distribution of the estimated coefficients of treat*post.

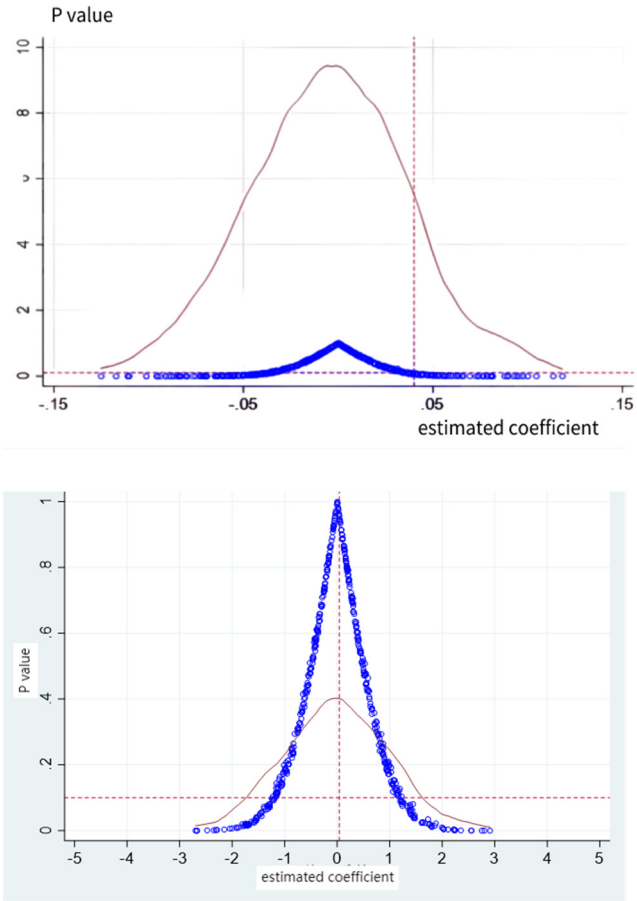

Figure 3. Placebo test with SER/RAT as explanatory variable

Under the 500 random sampling condition, if the estimated coefficients of the spurious treat*post are distributed near 0 and most of the estimated coefficients are smaller than the results of the benchmark regression, it can be said that the placebo test is passed. As can be seen from Figure 3, the estimated coefficients of the spurious treat*post are around 0 and all of them are smaller than the true regression coefficient of the benchmark regression of 0.071 in Table 3,

and the results of the fictitious regression coefficients are significantly different from those of the true regression coefficients, which suggests that there is almost no effect of the unobserved variables on the industrial structure of the advanced level. And as seen in Figure 3, the estimated coefficients of the fictitious treat*post are around 0 and are all smaller than the true regression coefficient of -1.743 for the benchmark regression, indicating that the unobserved variables have almost no effect on the rationalisation of industrial structure. Therefore, the model setup does not have serious problems such as omitted variables, and the results are robust, further verifying that the establishment of a pilot zone can promote the optimisation of industrial structure.

5. Conclusion

Firstly, this paper combs through the theoretical foundation and domestic and international literature on the relevant topics, and uses enough theories and existing research to support the relationship between comprehensive test zones and industrial structure optimisation. On this basis, this paper analyses the influence mechanism of pilot zones to promote the optimisation of industrial structure in terms of the innovation-driven effect, the industrial aggregation effect, and the resource allocation effect, and lays down the theoretical foundation. Secondly, this paper elaborates the development status quo of domestic pilot zones and the industrial development status quo of the Yangtze River Delta region, and puts forward the problems that the region may face in the process of the development of the industrial structure, which provides certain practical support for the next empirical research. Again, based on the panel data of 41 cities in the Yangtze River Delta region from 2011 to 2020, this paper adopts the multi-period double-difference method to test the impact of the construction of the pilot zone on the optimisation of the industrial structure of the Yangtze River Delta region, and performs a series of robustness tests, and carries out a heterogeneity analysis in terms of the successive batches, the high and low levels of administrative hierarchies, and the sizes of the cities. Finally, based on the above theoretical mechanism analyses, this paper conducted an impact mechanism test. The main research conclusions of this paper are obtained as follows.

The analysis of the current situation shows that: from the perspective of cross-border e-commerce development, the Yangtze River Delta region covers a number of well-known cross-border e-commerce enterprises, which, relying on the Yangtze River Delta region's superior geographic location, convenient transport network and rich market resources, and at the same time, actively expanding their cross-border e-commerce business by drawing on the pioneering experience of Hangzhou Comprehensive Pilot Zone, have achieved very significant results. From the perspective of the industrial structure of the Yangtze River Delta region, in 2020, the output value of the secondary industry in Shanghai will be reduced to 26.59%. The primary industry has decreased from 0.65% in 2011 to 0.27% in 2020, which is a typical city for the optimisation and upgrading of China's industrial structure. After the tertiary industry exceeded the proportion of the secondary industry in 2015, the industrial pattern of Jiangsu Province began to change from "two, three, one" to "three, two, one". In Zhejiang Province, the output value of the tertiary industry accounted for 53.6 per cent of the total output value, showing a pattern of "three, two, one". Compared with other provinces and cities in Anhui Province, the optimisation of industrial structure lags behind a little bit, and by 2020, the structure of the three industries will be adjusted to 9.5:41.2:49.3, which shows that the tertiary industry is developing faster than the primary and secondary industries, and the industrial structure has already been

transformed into "three, two, one". Although the overall development of e-commerce in the Yangtze River Delta region is good, there are still some challenges and problems. For example, as a whole, the development of e-commerce in Jiangsu, Zhejiang and Shanghai is ahead of Anhui, while in terms of Anhui Province, Hefei and Wuhu e-commerce development is faster, while other cities are slower, resulting in an uncoordinated industrial structure. In addition, the diffusion effect, the siphon effect, and the similarity between industries may make the optimisation of the industrial structure of the Yangtze River Delta negatively affected.

Benchmark regression analysis shows that after controlling for city, time effect and related control variables, the regression coefficients of pilot zones on the optimisation of industrial structure are 0.071 and -1.743, which pass the significance level of 1% and 5%, respectively, indicating that pilot zones have a significant contributing effect on the optimisation of industrial structure. The above conclusions still hold significantly after a series of robustness tests such as placebo test, PSM-DID, instrumental variables, substitution of explanatory variables, and one period of policy lag, on the premise of satisfying the parallel trend test. The analysis of heterogeneity and the analysis of influence mechanism show that: the policy effects of the first two batches of cities established in the pilot zones are more significant than those of the last three batches; compared with the low-ranking cities, the high-ranking cities obtain more resources due to resource allocation and other factors, and the promotion effect of the high-ranking cities on the optimisation of industrial structure is more significant; the establishment of pilot zones has a significant effect on the industrial structure optimisation of the large-scale cities as well as the extra-large and above-average types of cities. The establishment of the pilot zone has a significant impact on the optimisation of industrial structure in large cities and mega cities and above, while the impact on the optimisation of industrial structure in small and medium-sized cities is not significant. The influence mechanism shows that the construction of the pilot zones can optimise the industrial structure through the innovation-driven effect, the industrial aggregation effect and the allocation of resources.

6. Recommendations

Firstly, the government should continue to expand the pilot scope of the comprehensive pilot zones for cross-border e-commerce and actively explore the mechanism for the elimination of the winners and the losers nationwide.2021 The Ministry of Commerce has already begun to implement an assessment mechanism, but a sound assessment and exit mechanism is lacking. Therefore, a dynamic management mechanism should be established to ensure the survival of the best and the worst in the comprehensive pilot zones, and regular assessments should be conducted to promote their development. Secondly, the government should improve the construction of offline cross-border e-commerce industrial parks, improve the park service support system, absorb advanced e-commerce technologies and concepts at home and abroad, and achieve real innovation and breakthroughs in all aspects of processes, modes, and management styles in order to maximize the rapid growth of cross-border e-commerce to promote industrial aggregation. Thirdly, local governments should combine the regional industrial structure and innovation resource endowment, and focus on strengthening innovation reform strategic initiatives that are effectively synergistic with industrial digitalisation and low-carbon transformation and upgrading. At the same time, appropriate industrial policies should be formulated to guide the effective agglomeration of medium- and high-end strategic emerging

industries, and to make concerted efforts from both the supply side and the demand side, so as to provide material safeguards and demand-driven for the synergistic interaction and in-depth integration of innovation reform and industrial upgrading.

References

[1] Carree, Martin, and A. Roy Thurik. Industrial structure and economic growth. Cambridge: Cambridge University Press, 1999.

[2] Kalita, Kanak, et al. "A Fuzzy MARCOS-Based Analysis of Dragonfly Algorithm Variants in Industrial Optimization Problems." Informatica 35.1 (2024): 155-178.

[3] Unger, Gabriel. The Macroeconomics of Structural Transformation. Harvard University, 2023.

[4] Giza, Wojciech. "Asymmetric information as a market failure in retrospect." The Elgar Companion to Information Economics. Edward Elgar Publishing, 2024. 106-117.

[5] Mazzucato, Mariana. "Governing the economics of the common good: from correcting market failures to shaping collective goals." Journal of Economic Policy Reform 27.1 (2024): 1-24.

[6] Zhang, Guoxing, et al. "Impact of environmental regulations on industrial structure upgrading: An empirical study on Beijing-Tianjin-Hebei region in China." Journal of Cleaner Production 238 (2019): 117848.

[7] Callaway, Brantly, Andrew Goodman-Bacon, and Pedro HC Sant'Anna. Difference-in-differences with a continuous treatment. No. w32117. National Bureau of Economic Research, 2024.

[8] Rios-Avila, Fernando, Pedro Sant'Anna, and Brantly Callaway. "CSDID: Stata module for the estimation of Difference-in-Difference models with multiple time periods." (2023).

[9] Kuroiwa, Ikuo, and So Umezaki. "Upgrading in GVCs." Global Value Chains and Industrial Development: Participation, Upgrading, and Connectivity. Singapore: Springer Nature Singapore, 2024. 47-71.

[10] Athey, Susan, et al. "Matrix completion methods for causal panel data models." Journal of the American Statistical Association 116.536 (2021): 1716-1730.

[11] Beck, Thorsten, Ross Levine, and Alexey Levkov. "Big bad banks? The winners and losers from bank deregulation in the United States." The journal of finance 65.5 (2010): 1637-1667.